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PROCEEDINGS OF THE PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

At the sixth annual meeting held at the Manufacturers' Club, Philadelphia, the following officers were elected:

President—P. D. Wanner.
Vice-President—Antonio Y. Pessano.
Treasurer—Josiah Thompson.
Secretary—Howard Evans.
Executive Committee—Walter Wood, chairman; Thomas Glover, E. E. Brown, Stanley G. Flagg, Jr., Wm. F. Sauter.

The expressions made as to the state of the foundry trade did not reflect any apparent improvement in either the volume of business offered or the prices obtained.

Mr. Moore, of Elizabethport, N. J., said that a recent trip abroad had convinced him that he could have taken orders in England for castings at satisfactory prices to himself and at less than the prevailing price in that country, where ordinary castings cost from two and one-half to three cents per pound.

Malcolm McDowell, of Chicago, read a paper on "The Practical Value of the Various Metalloids in Cast Iron," which represented further investigations made by the author since presenting his last paper before the Western Foundrymen's Association.

PROCEEDINGS OF THE WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular meeting of the Western Foundrymen's Association was held Wednesday evening, November 17.

The paper of the evening, prepared by John C. Knoeppel, of Buffalo, was then read by the secretary, as follows:

"PLASTER CASTS AND OTHER METHODS OF MOLDING SHELL FORMS."

The art of constructing plaster casts for the purpose of taking off patterns in metal belongs more to the pattern maker than to the foundryman. The molder is not expected to learn this branch of the trade, as it is not universally practiced, and probably not understood by many engaged in foundry work, being more in the line of pattern work.

I will proceed at once to give you a full description of the method, process, and manner of molding and casting the same, and will try to be as plain as possible so that it will be clearly understood. This form and method of pattern making is very simple and inexpensive, yet very precise and accurate, especially so on irregular work—as patterns that require backing out, such as deep-figured, carved and ornamental designs. To properly back out a pattern so as to make it the required thickness, and at the same time produce an even pattern, requires great care and tedious labor. We all know that to make patterns for shell forms of any size or shape requires much time, and in many cases untrue or uneven patterns are the result, when built of lumber, causing considerable trouble to the foundryman in using the same in sand, on account of their being warped and out of shape.

In making patterns in plaster we first have the outer form made of wood in a block shape. Sometimes this outer part is made of plaster by the aid of suitable sweeps, afterwards having such ornamentations and figures placed thereon as are called for by the designer.

When the pattern is completed, have a true board made with battens on and tongued on the end to keep it from warping. Fasten the block to it with screws from the under side, varnish the same and allow it to dry. Then have a flask made for the purpose with an extra nowel part, properly fitted with pins and eyes alike and to suit pattern board. We are now ready for the plaster cast.

Put the pattern board on a bed of sand, fitting the extra nowel to it, and clamp the same. Before pouring in the plaster, oil well the pattern and board, olive oil being preferable. Now mix the plaster paris with water sufficient to give it the consistency of thin mortar, so that it will find its own way to all parts of the pattern, and of sufficient quantity to fill the nowel, allowing it a short time to settle, then strike off and put on a bottom board, and secure with screws. Mixing a little parting sand with the plaster hardens it, and it will dry quicker, and have less blow holes and bubbles. After a lapse of fifteen to twenty minutes, roll over the plaster cast, and unscrew the pattern from the board, taking off the board, the pattern proper still remaining in the plaster. Rap carefully and draw it out of the plaster. You now have an impression the reverse of your pattern. While the plaster is drying take the block pattern and put it back to its original position, being careful to clean it well before using it for molding from it. At this point you have a concave and convex form of pattern. The plaster cast should be allowed to dry for at least fifteen hours, but could be dried in less time with moderate heat.

We are now ready for filling up the thickness in the plaster cast. Have a true board made, with strips of the required thickness fastened to it at each end. This board should be about the size of a kneading board, such as is used in our homes. Mix up a composition of whiting and melted beeswax to the consistency of stiff dough, and then with a rolling-pin roll out suitable sheets, cutting them into different sizes to suit the work, laying and pressing them carefully in and against the surface part of the cast, using suitable tools, the hand and fingers coming into play frequently. Secure the filling with tacks.

This filling or thickness composition should be put only where the pattern-line shows; all of it should be well varnished, and when sufficiently dry proceed to mold.

Take the bottom board and pattern, place the nowel for the purpose upon it, being careful that there is no shift, and fit into the pins on board tight; ram this up with sand in the usual way, treating the mold as you would ordinarily, clamping the same as in the case of pattern-making or molding. Roll over on bed, and unscrew the pattern from board, taking this off; draw out the pattern proper, and finish in the usual way; then proceed to the cope part. Take the plaster cast and place the cope on it, using the same precautions as with the pattern. Provide suitable gates for pouring, and ram this part up with sand also. Roll over, being very careful not to disturb the mold in drawing the cast off the cope. Finish as usual.

We now have both nowel and cope part. Close these two parts together, marking the gating points with flour; take off the cope again, cut the gates, reclose flush, and clamp on.

When you are ready for the metal, before closing for the last time, be sure that the parting-line meets. A little flour will help to fill up if a little slack, thus producing an economical, as well as a very true and reliable mold. Sometimes a right and a left form are necessary; such as for heads, birds, animals, and statuary, to produce a full form. In that case, both sides are made in the manner described above.

While at work some years ago in one of the Western foundries, a large number of their patterns were broken and patched so much, that they made heavy as well as unsightly castings. The original could not be had, and of course could not be duplicated. I then suggested plaster casts and the work was given me. Using the regular patterns to work from, the first cast was reduced about ten pounds over the old one. The result being satisfactory, I was given more to make up, due allowance being made for shrinkage.

A large variety of subjects can be made of plaster, and when once acquainted with this branch, many lines can be pursued for plumber's work, tees, elbows, branch-pipes, hoppers, etc. These

casts can be preserved for future use, or a number of master patterns may be taken off and stored.

Another way to take off good block patterns is by stripping. While it is not as accurate and precise as the plaster cast, yet it will answer in many cases. The plan is similar to that mentioned, but instead of plaster, we work the block directly with sand. The block is made and secured to a true board, as in the case of plaster casts. A cope is fitted to it, and rammed very hard with common sand and rolled over. The board is taken off and the pattern drawn out. Suitable wooden strips are cut to conform to the work and of the required thickness. Now have sufficient paper on hand, cutting the same into suitable strips, and lay it on the surface of the mold, and nail the paper to the sand until the required thickness is obtained. Then commence laying on the wooden strips, these being cut large or small as required. After all is filled up even with the joint, fill in with fine sand. This might be done while laying in the wooden strips, to keep them from falling out of place, being careful not to disturb any part of the mold. Then place the nowel upon the cope, and ram up in the usual manner; roll over carefully and take off cope—the cope is what we term a false coping, and is shaken out. After cleaning off the pattern, prepare the cope in the usual way. Put it on the pattern board with block fastened thereon, clamping and setting the gate pins, and ramming up with sand. This needs to be treated differently from the first case, not ramming too hard, and in the regular way, as in the course of molding. Roll over, take off the board, and draw out the pattern. Now finish both parts—nowel and cope. When completed, close cope on the nowel, put a little flour on the joint with a bag, lift off and see if joints touch and meet, and join securely; see if you have even thickness; then close again, and the mold is ready for pouring.

Almost any form of work of a smooth character can be made in this manner, such as kettles, pipes, drum-tanks, bath tubs, etc.

Still another simple way is to make a core the desired shape with a sweep, drying it, and then with the thickness strips laid on the core, ram up the balance of the mold.

A few years ago I made a steam receiver, with reducing end and flanges, 30 inches in diameter, 10 feet long, reducing end being about 20 inches, weighing about 5,000 pounds.

The party wanted only one casting, and it would not pay to go to the expense of making a pattern. I proceeded as follows: Sweeps were made to conform to the shape at each end and at the center. A skeleton frame was also made, and was laid on core plates made in halves and dried, with proper core irons, having suitable holes drilled and threaded to handle them in lifting. I placed one-half on mold board, placing the flanges at each end, and having the thickness strips ready to lay on the core, rammed up in the usual way with sand; rolled over, and made joint; put on the other half core, and stripped it as in the nowel, being careful that they corresponded with each other. Put on the cope, and set the gate pins, and rammed up. After lifting off we took out the cores and returned them to oven for redrying, finished the mold, setting chaplets, and resetting cores—the latter providing their own prints. This was cast in green sand, and turned out very well.

DISCUSSION.

Mr. Baer: We have done some of this kind of work. I think it can be worked very successfully if the men understand it. We have had some experience, and had good success.

Mr. Sercomb: There is one thing in the paper that struck me, and that was that the writer did not refer to the expansion or contraction of the plaster after forming the mold. Information as to the expansion or contraction would be valuable.

Mr. Baer: There would be a shrinkage, if anything. If you had to nail the board on before pouring, it would shrink away from the frame and drop.

Mr. Ott: I have never had any experience in making ornamental patterns, but I have made a great many casts of plaster of Paris. The only time that I ever found that plaster of Paris expanded was when we put the wood into sand. I would suggest the use of emery dust instead of sand. It causes the plaster cast to

harden so that you can hardly cut it with a chisel or knife. I always use emery dust if I can get it. I have made light plaster of Paris patterns, but I have never paid much attention to the expansion or contraction.

Mr. Smith: I saw this work done about eighteen years ago. We made a kind of mantel work, and in making the mantel shelves at that time we called this reversing. I did not understand it as pattern making, but as molding. We made it directly in green sand. We took a copy from the pattern made from layers of composition of clay. The way this is described in the paper seems expensive. I should like to know which would be the more expensive: To make the mold directly in green sand, or from plaster casts.

Mr. Louis Knapp: Instead of being confined to the iron foundry, I think if we should talk this over with people interested in bronze and light metal work they would give us some information. They do a great deal of this plaster work. It is very fine for core-boxes.

Mr. Ferguson: Although I am not very familiar with reversing or making of patterns as described, the principle of the thing is applied, I believe, in all foundries—in all classes of molding, green sand and dry sand molding, and loam molding—in getting the one side of the pattern. Suppose you are making a stove door. You make a plaster cast of the door, and make the bottom part of the mold and get the cope from it. The same thing is applied in making a kettle, exactly. Sweep up the outside and inside the full size, and then take off the thickness. It is the same principle. So it is true in making pipe of all kinds. That is another application of the same principle. I think you will find it in regular practice everywhere.

Mr. Thompson: I can see where the putting on of this strip can be made of considerable advantage in ornamental work or in the making of core boxes. But in making a pipe or receiver, it seems to me that the ordinary way of sweeping up from a spindle with bearings at each end would be a cheaper way of making the casting. This material is expensive. The same in

making kettles and anything that can be swept up. I do not see there is any advantage gained by using any material for putting on the thickness; for where the outside diameter is swept up first, and the cope rammed on that, and then the thickness put on the sweep, and the sweep put in the mold after the cope has been taken out, and the thickness swept up that way, it seems to me it is plainer and cheaper; and I think we can apply it to everything but ornamental work.

Mr. Baer: The gentlemen is right there. As I understand it, this method is used principally on ornamental work. In pipe or kettle work you can sweep readily in green sand, and it is much easier than plaster of Paris, by having a double sweep.

On motion, the secretary was instructed to extend to Mr. Knoeppel a vote of thanks for his very excellent paper. It was decided that after the reading of the regular paper at the next meeting, the discussion be resumed of the paper of Mr. Truesdale, which was read and discussed at the Cincinnati meeting.

PROCEEDINGS OF THE PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The regular meeting of this association was held November 22. The paper of the evening was read by Dr. Richard Moldenke, consulting engineer of the McConway & Torley Co., of Pittsburg, whose subject was

"TEST BARS IN THE FOUNDRY."

I must claim the indulgence of the Pittsburg Foundrymen's Association for bringing up what would seem to be a well ventilated subject; but, believe me, the progress of the iron industry is such that it will not be long before strict specifications govern the production of castings for structural and other work, and founders might then wish they had made the first move toward standard methods of testing their work. To illustrate this more fully:—Suppose an engineer is getting up a set of specifications for the cast iron work of some structure in which the castings are subject to tension. As there is little information to be had on this point, he first obtains a lot of samples, tests them, and very likely, knowing little or nothing about iron mixing and founding, selects the piece giving the highest tensile strength for his standard. Suppose this to run 30,000 lbs. to the square inch; straightway he will write 32,000 and hold the founder for its production. The original test piece was probably a white or at least hard iron, strong to the pull, but unfit for shock; consequently, instead of obtaining what he really should have, a serviceable, sound, strong casting, he calls for just the reverse.

So you see that by leaving the question of judging cast iron to those not acquainted with foundry practice, undesirable and positively injurious results may follow. Is there any wonder, then, that where cast iron is to be used for constructions subject to shock, a factor of safety up to 20 is currently found necessary. All this reacts on the founder himself, and retards the use of his product in the onward march of the industry.

You will probably wonder where the test bar comes in. It is here:—If you are asked to furnish castings, and are required to

pour test bars with the same iron for the information of the buyer, you can easily manipulate these bars to a sufficient extent in the direction of the qualities called for, to cause a considerable difference between them and the actual castings. The object of a standard set of specifications for the preparation and shape of test bars, to cover all branches of the trade, has for its main object the protection of the buyer, and of the conscientious founder who wishes to stand on the merits of his product.

The nature of the mold, the heat of the iron, the style of the test bar, the method of molding and casting it, and a number of conditions known to the founder, and to him only, have an ultimate effect on the test bar which may cause the rejection of good sound castings as easily as their acceptance, and endless would be the disputes between buyer and seller if this matter is not satisfactorily standardized.

It is to be understood that it may be some time yet before the general foundry trade is required to work under specifications, and many branches of the industry in which the intimate knowledge required is not available to outsiders, may never be called upon the work to closely drawn lines. Yet that this time is coming must be patent to all who have watched the trend of things for the last decade.

The buyer is quick to note any improvement made in a product, as shown him by an anxious seller, and when this knowledge becomes public property it is better to find the founder prepared than to allow the general disturbance in the trade which is sure to result. Again it is to be hoped that the founder may yet have time to solve some of the numerous and perplexing questions arising in the course of his work, before he is called upon to guarantee results which at the present time he very much desires, but cannot always attain.

Attention has been called to the desirability of taking action, on the part of the foundrymen as a national body, on this very point, thus fixing their status when it comes to international action. The engineering, iron, steel, and machinery interests are ready to impress their views on such action. Should this be al-

lowed to go through at the expense of the founder? Let us hope not. A test bar must be made first, and then tested. In the making of the test bar to represent truly the castings, let every one give way to the founder; in its testing he will be glad to stand back and let his work rest on its own merits.

The question of working out such standards means very much and hard study. A review of everything now known to us here and to our friends across the water would form the starting point. An exhaustive discussion of the question in the individual associations would bring out many points, which if properly collected could form the basis of a series of experiments to obtain the data necessary. To be effective, however, action must be taken under authority and with the influence of the national body of foundrymen. For with this, and later on international action, a code of such authoritative standing would result, that foundrymen all over the world would find in it protection from the annoyance of having their hands tied in their own works by inspectors watching their production of work based upon a variety of more or less stiffly drawn specifications.

Several years of patient investigation, comparison, and careful study will be necessary to arrive at a proper set of recommendations for national and international approval, and this latter part of the programme is not so difficult for us Americans, as might be supposed, for there are a number of foundrymen in the national body who are at the same time members of the "International Society for Uniform Methods of Testing Materials of Construction." In the next, the Paris meeting of 1900, they could ably take care of the American foundrymen's interests, provided the folk on the other side be asked to work in harmony with us from now on.

To allay the mistrust on the part of conservative foundrymen, it may be stated that the proposed action is not to make cast iron rules regarding the strength or quality of the product of foundries, but only to fix absolutely and authoritatively the shape and method of preparation of the test piece from which the casting may be judged. We are all anxious to get out the best and

strongest castings, but it would surely be asking too much of us to tell everybody what results we were getting, unless we were so inclined.

Now for another side of the question. Going back to the basis of the foundry business—the pig iron—we find that there is a great difference in the behavior of irons made by various blast furnaces, even where the chemical composition is identical. This can be traced in a measure to the ores, fuel and fluxes used, just as in the refining of copper the accidental introduction of sulphur, although it is wholly removed afterwards in the polling of the bath, leaves its effect on the ingots unmistakably and to their disadvantage. Then, also, the method of running the blast furnace has much to do with the resulting pig metal. If, now, there is this difference in the strength of irons of the same chemical composition (and I have found it again and again), the founder can demand protection from the poorer grades by calling for standard test bars for comparison with brands of known excellence, and the producers of high grades of iron will be glad to avail themselves of the opportunity to offer them and thus reap the profits coincident with conscientious and high-grade work.

Then will come about quickly a marked change in the blast furnace industry, so far as foundry irons are concerned, and when job lots of "off" casts are offered, a practical guarantee of their suitability for foundry purposes will be demanded, and in fact offered, for I will repeat here that the chemical composition alone is not enough to determine the quality of iron. An account must be taken of the physical characteristics also, so that by the combined use of chemical analysis and physical tests, as obtained from proper test bars, we have the best guide for the production of the kind of work we are after.

So, while at first the adoption of a standard system of preparing test bars seems an undesirable innovation in the foundry business, the results which come from it will be beneficial in the end and mean increased business for the progressive part of the trade. It seems to me that whoever has joined one of the various foundrymen's associations has shown his desire to progress, and he

will thoroughly appreciate the advantages which come to those who are found in the front ranks of the trade at all times.

The question of test bars is one of the first to come up in connection with the technical advancement of the foundry business; the rest will follow as a matter of course. May the few ideas here presented find sufficient attention among foundrymen to cause a little reflection, and lead to definite action of some kind on the part of the national body.

After the reading of the paper Mr. Kreuzpointner was asked to speak, and made a vigorous plea for an international system of tests. It has been attempted for five years, he said, to reach a chemical standard that would be acceptable to all, but the result is no nearer than when this effort was first begun. The solution lies in a different direction. The standard must be international, and every trade should have a voice in fixing its own standard. Let the shoemaker stick to his last. Mr. Kreuzpointner then urged the necessity of technical education in view of our increasing trade with foreign countries. European countries, he said, started in this direction one hundred years before us. Since 1828, in Munich, the professors of the universities have conducted schools for boys on Sunday afternoons, and attendance by the boys was compulsory. Successfully passing an examination freed them from apprenticeship. In France, Napoleon personally visited high schools and colleges and ordered that Greek and Latin be no longer taught, but in their stead were prescribed technical subjects. The methods of testing were discussed in detail and the proper procedure, the speaker declared, was to be found in following closely nature's laws. The talk evoked commendation and also a lively discussion.

The following contribution to the discussion, sent by Thos. D. West, was read by the secretary: "So many subjects are suggested by Dr. Moldenke's valuable paper that one is at a loss to select. It is gratifying to note the stand Dr. Moldenke takes on the necessity of a uniform system of physical tests. Many are awakening to the fact that the near future will see the strict specifications governing the production of castings, to which Dr.

Moldenke's paper calls our attention, and founders will be wise to heed his warning. Not only should general interest be taken in establishing standard methods for physical testing, but also for chemical analysis as far as this is practical. Where founders are working under the guidance of one chemist, or receiving iron from one furnace or locality only, they are not deterred from making true comparisons in working toward desired physical results. But let these conditions change, and varying methods in chemical laboratory work might cause grievous results. Believing that good can come from ascertaining to what degree analyses may differ, where drillings from the same pig are presented for determination, I have decided to try to obtain such analyses from blast furnacemen in different sections. My hope is that the results may further the general adoption of some one system of chemical analyses for pig iron.

"Some may say that progress might be such that the methods adopted to-day could be cheapened one-half to-morrow. Nevertheless, while this might be true, the loss in this respect, until the majority could change to the cheaper method, would be small compared with the benefit sure to result to furnacemen by lessening complaints of iron not being what was wanted by the founder.

"In order to expedite this work I would kindly ask furnacemen sufficiently interested in the subject to make one set of analyses, including the carbons, silicon, sulphur, manganese and phosphorus, to address me at Sharpsville, Pa. The drillings from one pig which I would send in response would of course be thoroughly mixed, to make sure all received the same stock. In returning a complete analysis, it would also be of interest to have the furnacemen state the methods they use, and the time each determination had taken. In cases where they prefer not to have their names or methods mentioned, such request would be cheerfully complied with. The possession of complete analyses, showing what differences may result by reason of non-uniformity in methods, would in itself pay for the labor expended, and greatly further the object sought. The returns, as soon as compiled, I would present in a paper to this Association."

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

AMERICAN MACHINIST.

November 4.—A. L. Bowen illustrates a method of making annealing boxes of different sizes from one pattern.

November 25.—An illustrated article on "Mitis Founding" appears in this issue, giving details of furnace construction.

H. O'Neil contributes an article on "Foundry Practice," in which he shows how bad results are often due to mismanagement, over which the molder has no control.

AMERICAN MANUFACTURER.

This journal has a condensed translation of a paper read at a meeting of the German Foundrymen's Association at Goslar, September 16. The subject of the paper is, "The Valuation of Pig Iron in Foundry Practice," the author being Dr. Wuest. We reproduce the paper below:

"The Valuation of Pig Iron in Foundry Practice."

It is still the custom of founders to rate foundry iron according to its fracture. If the fracture surface possesses a coarsely crystalline, dark gray graphitic appearance, the iron will be rated as No. 1, while fine-grain iron will be rated as No. 2 or No. 3. The difference in the price originating from the different appearance of the fracture, amounts to at least one-tenth of the total value of the raw material. Yet appearances are often deceiving. The value of pig iron does not depend upon its attractive appearance, but solely upon its chemical composition.

The higher the temperature of the blast furnace, and the slower the cooling of the iron, the coarser its grain. It can be assumed in a general way that a coarsely grained pig iron will always contain considerably more than 3.5 per cent carbon, beside 2.2 to 3.5 per cent silicon, and, therefore, be a good iron. But the coarseness or fineness of the grain does not depend upon the chemical

composition of the pig iron alone, but also upon the heating and cooling. Hence, no positive conclusions can be drawn from the appearance of the fracture as to the chemical composition of the pig iron, and especially as to the all important silicon contents. It is possible, by delaying the cooling process, to give to high carbon but low silicon iron the same fracture appearance as a higher silicon iron possesses. But for improving the mixture such iron is of no value.

The value of a pig iron for foundry purposes depends evidently upon the amount of scrap which can be added to it without rendering the casting too hard or brittle. It is well known that the yield in castings varies considerably, that is, not all the iron charged enters the casting. With small castings the yield ranges between 55 and 60 per cent, with large castings between 85 and 90 per cent. The deficit is due to loss by burning, pouring, and bad castings, which latter are again utilized as scrap. As with each remelt of gray pig the silicon and graphite contents decrease, all this cast and machinery scrap requires a silicon addition. In most cases the foundry uses not only its own scrap, but also other scrap is bought up, which is always cheaper than pig iron. It is, therefore, to the founder's profit to use as much scrap for his mixtures as possible in order to cheapen the product. Now it is customary to base the addition of scrap, ferro-silicon, etc., upon the appearance of the fracture of the pig iron. But the appearance of the fracture is often deceptive, and the chemical composition of the same grade of pig iron may also change. Hence, this method of composing the mixture is a very unsafe one.

It is impossible in blast furnace practice to constantly produce iron of the same nature. Its composition changes with each tapping, and even with the most careful charging an important metalloid may be present in one case in abundance, in another it may be lacking.

If the founder makes his mixture without possessing any knowledge of the change in his pig, he may obtain in one case a casting of doubtful quality, and in another he should have added more scrap. He has thus permitted a profit to slip through his fingers. Some founders try to prevent this loss by using three,

four, or more kinds of pig iron for their mixture, and in most cases they attain their purpose, but it is rather awkward to work with so many different irons.

The quantity of scrap that can be added to a pig iron depends entirely upon its silicon contents. The more silicon in the iron, the more scrap it can stand without rendering the casting hard and brittle. Silicon in foundry pig, however, should not exceed 4 to 5 per cent, as with the increase of silicon carbon decreases. There is, therefore, an upper limit for the silicon contents, for with too high contents of silicon there would be a lack of carbon for the formation of graphite. Here is to be found another reason why an iron rich in silicon and valuable for the foundry does not show a coarse grain, and is rated as No. 3 according to the present method of valuation by fracture, which should really be thrown overboard for good.

Too much value is generally given to the presence of carbon, as compared with the presence of silicon. In the case of a real lack of carbon, the pig iron mixture, provided it is not oversaturated by silicon, will experience in the cupola an enrichment of its carbon contents. The fluid pig will dissolve carbon from the coke as sugar is absorbed by water flowing over it. It may be taken for granted that the carbon contents of an iron mixture melted in the cupola do not sink below 3 per cent, and even if steel scrap alone is melted, its carbon contents will approach 3 per cent, that is, the steel has changed in the cupola to pig iron. Three per cent carbon, however, is sufficient for the separation of graphite, provided there is enough silicon present. Carbon contents not exceeding 3.5 per cent are more favorable for the production of dense, fine-grained, and tough castings than higher carbon contents which are apt to make the surface of thick-walled castings too soft. Therefore, in estimating the value of foundry iron, carbon plays only a secondary part.

In addition to the silicon and the manner of cooling, the manganese contents influence the form in which carbon is present in pig iron. Manganese prevents the separation of carbon in the form of graphite, the carbon remains suspended in the iron during its solidification, and the result is a hard, brittle casting. Whether

1 per cent manganese exercises a decisive hardening, may be doubted; certain it is that there can be no objection to .7 to .8 per cent of manganese in the casting. In the pig iron, however, somewhat higher manganese contents are desirable. By passing into the slag manganese protects silicon from burning during melting, thus keeping that valuable component in the iron. Of two kinds of pig iron with equal silicon contents the one with the higher manganese contents can be melted oftener in the cupola without becoming white than that with lower contents of manganese. Besides, a considerable quantity of manganese is a guarantee that the iron in question contains little sulphur. Manganiferous iron is usually poor in sulphur, as the manganese combines in the fluid metal with sulphur to form sulphuret of manganese, which latter is insoluble in the iron bath, and goes into the slag.

The influence of sulphur in making castings brittle can be proved only in a case where no flux has been added to the coke, so as the first tappings absorbed all sulphur from the coke. Under normal conditions, however, the sulphur contents in foundry pig are confined within such low limits, and can be kept from the iron by suitable means, such as non-sulphurous coke, abundant addition of flux, etc., so that no hardening influence can be proved for sulphur. Of course, the physical conditions during casting have great influence upon the quality of the casting, as the extent of the graphite formation depends not only upon the chemical composition, but also upon heating and cooling. A mixture poured into the mold in a highly overheated condition brings, per weight unit of the fluid metal, more heat into the mold than a less heated mixture. The former mixture may produce a workable gray casting, but it is doubtful in the case of the latter. The chilling action of the mold should also be considered, and in this respect the thickness of the casting plays the dominant part. The thinner the wall of the casting, the greater the chill. A mixture which, in the production of thin-walled articles, furnishes hard, useless castings, may prove excellent for heavy castings. Hence, in making his mixture, the founder should consider whether it be for light or heavy castings, and in the former case he should counteract the effects of quicker cooling by a larger addition of silicon.

Another important point is whether a dry or wet mold is used. When casting in wet sand, the hot metal has not only to heat the mold, but also to evaporate the moisture in it, which ranges between 7 and 10 per cent. This quantity of heat is taken from the metal suddenly, hence it follows that a wet mold produces a stronger chill than a dry one. In this case more silicon has to be used also, if the castings are not to be hard and brittle. Too much silicon, on the other hand, is just as injurious as too little. In mixing pig and scrap there are, therefore, two things to be considered. The silicon contents should be in proper proportion to the thickness or strength of wall of the casting; that is, the thicker the casting the less silicon, the thinner the casting the more silicon, and allowance in fixing the silicon contents should be made in case a dry or a wet mold is to be used.

An analysis of 120 samples of the most different castings as to their silicon and manganese contents, and with due allowance whether a dry or wet mold was used, was made by the author, and the results permitted the establishing of the following relation between the wall strength of the castings and the silicon contents:

	Per cent si.
Castings of less than ½-inch wall strength require	2.5 to 2.3
From ½ to 1-inch	2.1 to 2.3
From 1 to 1½ inch	1.9 to 2.1
From 1½ to 2 inches	1.7 to 1.9
Of 2 inches and over	1.5 to 1.7

With a wet mold the silicon contents should approach the upper limit, with a dry mold the lower one. The weight of the casting may also be considered, for in the case of a heavy casting the silicon contents may be somewhat lower. The analysis of the 120 samples showed that 89 per cent of the castings which were of good quality were in conformity with the above stated requirements.

The task of putting the proper amount of silicon into a casting is accomplished by a quick and simple calculation. The silicon contents of the pig iron, of course, must be known; in this calculation it may amount to 3.5 per cent; the addition may be

coarse machinery scrap of about 1½ to 2 inches strength of wall, and, to judge by its fracture, 1.7 per cent silicon. This figure will hardly ever be estimated too high. The task is to make light castings of about ½-inch strength of wall, and containing 2.3 per cent of silicon.

55	pounds	pig iron	with 3.5 per cent	silicon=	1.63	pounds silicon
45	"	scrap	" 1.7 "	silicon=	0.76	" "
100	"	mixture contain			2.69	" "

Fifteen per cent silicon or 0.4 pound, burn away in the cupola, hence, the casting contains 2.29 per cent of silicon. With this method of mixing, the silicon contents will always be in close conformity with the dimensions of the casting. It is, however, absolutely necessary to know the chemical composition of the pig iron, not only regarding the silicon contents, but also the manganese contents, which in a good foundry iron should not fall below 0.7 per cent, nor exceed 1.3 per cent. Phosphorus should also receive due attention in the valuation of a foundry iron, for the more phosphorus in pig, the less valuable it is for foundry purposes. The subjoined table was prepared to form a guide for the valuation of pig iron so that proper mixtures may be prepared in the cheapest possible manner. As a basis for the valuation a silicon content of 2.5 per cent was assumed, and for each one-tenth of 1 per cent silicon 50 pfennigs per ton were added. The basis for pig iron with less than 0.1 per cent of phosphorus is fixed at 64 marks per ton, with 0.3 to 0.8 per cent P 62 marks, with 0.8 to 1.3 per cent P 59 marks, and with 1.3 to 1.8 per cent P 56 marks. This calculation is shown in the following table:

	Price per ton in Marks.			
Si.	0.1% P.	0.3-0.8% P.	0.8-1.3% P.	1.3-1.8% P.
2.0	61.50	59.50	56.50	53.50
2.1	62.00	60.00	57.00	54.00
2.2	62.50	60.50	57.50	54.50
2.3	63.00	61.00	58.00	55.00
2.4	63.50	61.50	58.50	55.50
2.5	64.00	62.00	59.00	56.00

2.6	64.50	62.50	59.50	56.50
2.7	65.00	63.00	60.00	57.00
2.8	65.50	63.50	60.50	57.50
2.9	66.00	64.00	61.00	58.00
3.0	66.50	64.50	61.50	58.50
3.5	69.00	67.00	64.00	61.00

In order to make a test whether this method of valuation actually corresponds to practical results in the foundry, let us figure out the price of a few mixtures. Taking the mixture as calculated on above, pig iron with 3.5 per cent Si and 0.1 per cent P costs 69 marks, the scrap will cost 52 marks, the casting is to contain 2.3 per cent Si. The cost of the mixture would be as follows:

	Marks.
55 lb. pig iron containing 1.93 lb. Si cost	1.90
45 lb. scrap containing 0.76 lb. Si cost	1.17
Total 100 lb. mixture containing 2.69 lb. Si cost	3.07

Loss of silicon by burning 15 per cent=0.4 lb.
Silicon in casting=2.29 lb. or 2.29 per cent.

Taking a 2.8 per cent silicon iron instead of the 3.5 per cent iron, the price per ton according to the above table would be 65 marks 50. To obtain the same mixture as above the following weights will be required.

	Marks.
90 lb. pig iron containing 2.52 lb. Si cost	2.95
10 lb. scrap containing 0.17 lb. Si cost	0.26
Total 100 lb. mixture containing 2.69 lb. Si cost	3.21

Loss of silicon by burning=0.4 lb.
Silicon in casting=2.29 lb. or 2.29 per cent.

It will be seen that for the production of light, thin-walled castings high priced, 3.5 per cent silicon iron offers a cheaper mixture than a cheaper pig with only 2.8 per cent silicon. It is the same with heavy castings. For instance, a heavy piece to contain 1.6 per cent Si is to be cast. The scrap used contains 1.7 per cent Si and costing 52 marks per ton, the pig, containing 2.9 per cent Si and 0.3 to 0.8 per cent P, cost 64 marks. The mixture has to be made as follows:

	Marks.
18 lb. pig iron containing 0.52 lb. Si costs	0.58
82 lb. scrap containing 1.39 lb. Si cost	2.13
Total 100 lb. mixture containing 1.90 lb. Si cost	2.71

Loss of silicon by burning 15 per cent=0.28 lb.
Silicon in casting=1.63 lb., or 1.63 per cent.

For the sake of comparison, take pig with 2.2 per cent Si and the same phosphorus contents (0.3 to 0.8), and costing M. 60.50. In this case mixture and cost would be as follows:

40 lb. pig iron containing 0.88 lb. Si cost	1.21
60 lb. scrap containing 1.02 lb. Si cost	1.56
Total 100 lb. mixture containing 1.90 lb. Si cost	2.77

Loss of silicon by burning 15 per cent=0.28 lb.
Silicon in casting=1.63 lb., or 1.63 per cent.

Here, too, the better, that is the higher silicon iron is the cheapest. All this shows that high silicon iron is the best and cheapest for the foundry, and that the proper way to estimate the value of foundry pig is by its silicon contents.

John S. Kennedy claims that the term, brown hematite, is a misnomer and advances the following arguments in support of his contention:

What may be called popular errors are the most difficult to correct. In the discussion of purely technical matter, even when viewed from the commercial standpoint, we should admit of no excuses for failure to properly designate the scientific distinctions when well defined. Although the term "brown hematite" has the sanction of long usage, it is none the less incorrect. A discussion of this subject may therefore be timely.

The ores of iron are readily divided into four main classes, viz: The magnetites, hematites, carbonates and hydrated sesquioxides or brown iron ores. It is in the careless discussion of the last named division that the error of calling the brown ores "brown hematites" has become almost justified by common usage. In spite of the fact that the derivation of hematite, Hemos, signifies red or blood colored, this confusion of terms exists and the ab-

surdity of speaking of a brown red ore is manifest. This distinction does not refer to the peculiar color of the ore itself but describes the characteristic ore streak on the unglazed porcelain test plate. These hydrated sesquioxides of iron should be called either brown iron ores or simply brown ores where the context is plainly understood.

The brown iron ores are subdivided into three classes, the distinguishing type characteristic of each being the respective content of combined water. These sub-divisions are as follows:

	Combined water.	Metallic iron.
Turgite	5.30	66.29
Gothite	10.10	62.93
Limonite	14.44	59.89

The above figures express the maximum theoretical percentages of combined water and metallic iron (Dana).

A careless misuse of the term "limonite" has become noticeable. It is often applied indiscriminately to brown ores, especially to the richer varieties from the limestone formations without reference to their type composition. The derivation of the word limonite signifies a meadow, as the bog iron ores, in their percentage composition, approach very closely the theoretical type called limonite.

It is evident that the proper classification of a brown iron ore can only be determined from its analysis. It is also true that the different ore types may be represented in the same deposit. It is not unusual to find two different types in the same brown ore sample, especially in geode formations. Hence no generic term, such as limonite, can be accurately used to designate a given brown iron ore without confirmatory analyses.

The brown iron ores are found widely distributed from the Metamorphic to the more recent formations. The terms "Potsdam," "limestone ores" from the Lower Silurian, "Hudson River" from the number III slates, "Medina" and others serve not only to distinguish the geological position of the ore bearing formations but also indicate in many cases the chemical composition of

the ores. To apply a term, as limonite, at random has no justification.

This discussion resolves itself into the query, shall we continue in a practice which has no scientific basis, an error into which the majority of us has fallen, even though it has become common usage, or shall we cultivate greater accuracy in speaking of brown iron ores?

A furnaceman asks the following question in regard to a statement appearing in one of the papers published in the November journal:

I note in an article published in a late number of your journal entitled "The Value of Physical Tests," by S. S. Knight, the following statement in comparing the shrinkage and analyses of two test bars: "Both bars were cast from the same ladle, one with the metal very hot and the other after the metal had been reheated by the addition of less than 5-10 of 1 per cent of ferro-manganese."

I must inquire how the addition of any proportion of ferro-manganese would increase the temperature of the bath or reheat the iron in the ladle.

In the Bessemer practice an addition of spiegel or ferro is sometimes made to the converter charge to save a cold heat. The introduction of the carbon, combined with the manganese and iron, permits of a further blowing of the heat, and by its oxidation by the oxygen of the blast furnishes additional heat units, and increases the temperature of the bath.

THE FOUNDRY.

In a continuation of "Some Pencil Sketches of Failures," Henry Hansen takes up Skimming Gates, and demonstrates why some of these, although ingeniously constructed, fail to work. We have selected the following paragraph to show the trend of the article:

"I take it for granted that every molder will acknowledge that it is easier for dirt to pass through a large aperture than a smaller one. Admitting that it takes a certain gate area in order to fill the

mold properly in a given length of time, we are still able to retain a constant gate area by a judicious distribution.

I remember a case where dirty castings were the rule, and the way the pig iron got the blame for it, which was entirely overcome by distributing the gate in a better manner. The cleanest castings will be found where narrow but long gates are used and the dirtiest where the gates are short and heavy, permitting impurities to pass unmolested into the mold when a narrow gate would retain them as a fine riddle keeps back finer pieces of scrap than a coarse one.

Aside from the gates being the means by which the metal is conveyed to the mold proper, it has been sought to incorporate in them, with more or less success, such a form of construction as to compel them to absorb whatever impurities may have come with the passage of the metal through the runner basin and part of the gate itself. Green sand work being much more susceptible to the agitation of the metal, it is from here that we receive the largest complaint of dirty castings. To prevent objectionable matter from entering the mold, gates are shaped so as to act as a preventive against this, and one of the best preventives is to fill the mold through narrow gates, which will largely prohibit the entrance of foreign matters.

Skimming gates take many forms according to the caprices of the foreman or the gullibility of the molder. Some shops, by careful gating, produce clean castings and ignore the skimming features altogether, while others would not think of pouring a grate bar unless a skimming gate is attached. The employment of skimming gates result in a correspondingly higher percentage of gates, and returns to the cupola and increase the cost to a certain extent.

There are two principles underlying all forms of skimming gates. The first, and this is the one most commonly employed, proceeds on the assumption that a light body will float on a heavier one. All impurities being lighter than iron, they will raise to the surface and occupy the highest strata, and with the

flow of metal directed through an entrance considerable below this, the source of supply is placed where it can be filled from the heaviest body.

In the second principle upon which is based the effectiveness of the skimming gate, and this is sometimes found in combination with the first one, a centripetal force is applied to the metal either as it enters the gate (the whirl gate is an example of this), or as it enters the mold. A notable instance of this is to be found in roll making. By this method the impurities are by the centripetal force made to move towards the center, where their presence is almost harmless, and away from the surface of the casting, where they would cause it to be condemned.

All skimming gates, no matter what is their shape or mode of construction, must be kept full in order to be effective. They only perform what is expected of them so long as we permit the lighter bodies or impurities to find a ready outlet through the correspondingly heavier mass of iron. All effective skimming gates are based upon the laws of gravitation, and when we interfere with these laws our skimming gates become inoperative.

In a letter to The Foundry, a writer signing himself "Hawkeye" dwells upon the value of charcoal facing, of which he says:

"The grade used for this purpose is ground somewhat coarser than that used for returning, and is supposed to be pure. A little of this facing shook on the pattern will produce castings true to pattern, and will save nearly half the time in milling, without wearing the corners off the castings. It also helps materially in doing good japanning, bronzing, nickel-plating and coppering.

"Some three years ago I happened to drop into a foundry near Chicago, which has the reputation of making very fine light castings. The foreman, a first-class man, too, called my attention to some very delicate castings that he had to make, and stated that he had lots of trouble with them, and could not make them nice enough. I suggested that he try charcoal. He did so, and was amazed at the results. He thanked me for the "pointer" and stated that he would never be out of charcoal in the future, and no

doubt he has used many barrels since. I do not want the readers of The Foundry to understand that I mean that good castings cannot be made without facings. On the contrary, in some classes of work they are only an expense, but on others they are an absolute necessity. Of course it is necessary to use judgment on everything. Charcoal may be more costly than ordinary bag facing, but if the quality of the castings is to be taken in consideration, it is by far the cheapest to use on light work."

In "Cast Iron Notes" Mr. Keep answers several questions relating to mixtures of iron. To an inquirer who wants to know the most suitable mixtures of cast iron for large magnets, Mr. Keep gives the following answer:

Probably this question relates to the frames and fields of dynamos. The best material would be soft steel, and manufacturers are using steel castings. The next best thing is to make the frame of cast iron, and bolt to this blocks of soft steel which are cast.

But the question is: Which cast iron mixture is best? There is great diversity of opinion regarding this, but the softest iron seems best. From the fact that soft steel is acknowledged to be the best material, it would seem that a casting having the least proportion of metalloids and the greatest percentage of iron would be best, but it must contain sufficient silicon to insure the least possible combined carbon. A good Bessemer pig should give the best results. The total carbon must be taken as it comes, and it will probably be about 3 per cent. If ordinary irons are to be used, add enough silicon to make soft castings, but not enough to prevent them being solid.

C. F. Logan brings up the question of chilled rolls cracking in cooling, and advances several theories to account for the phenomenon.

N. T. Arnold writes of the Doherty Process, and attempts to explain its superiority over the common method of melting.

IRON MOLDERS' JOURNAL.

In an article on "Bad Reasoning" a correspondent signing himself "Heptagon" alludes to the function of the whirlgate, as used in casting a roll, of which he says:

Why is the dirt thrown to the center of the surface of the metal in a roll or any circular mold similarly gated? Not simply because of the circular motion imparted to the liquid metal. But because the rapid circular motion makes the surface of the metal assume a concave form, the dirt gravitating to the lowest point. A very simple demonstration of this can be had by stirring a cup of tea, upon whose surface tea leaves are floating. As soon as you stir it rapidly enough to cause it to mount up the sides of the cup and form the concave surface seen in all whirlpools, the floating leaves will go to the center and remain there while the rapid circular motion continues. Applying this principle to the roll, we see how the slag is thrown and kept in the center while the metal rises in the mold and is carried safely into the riser head and out of the way. This rule is invariable—if a rapid whirling motion be imparted to the metal its surface will be concave and the dirt at the lowest point.

Molders often acquire an erroneous notion as to the functions of the various devices they use to promote the success of their work. The reason is that they don't think it out themselves; they are satisfied to take somebody else's "say so" and let it go at that. Foremen or journeymen, when telling an apprentice what to do to get the best results on a job, should also tell him why the treatment he recommends will give these results. That will cultivate in him the reasoning faculty and be of value to him as a mechanic. A mechanic is a thinker, and not an automaton.

IRON TRADE REVIEW.

We present the following from an article by R. Moldenke on "Chemistry in the Foundry":

"Aside from the fact that smaller foundries need only employ a chemist for a small portion of the day, and that there are numerous laboratories which make a business of supplying just such a demand, these larger plants which employ a metallurgist, and which formerly made their specialties with expensive irons, now use cheaper irons, and get just as good results. This very fact

has brought down the prices of charcoal iron, and other high grades, very considerably.

"The fact that some people who know very little about metallurgy have stumbled upon improvements in mixing iron without the aid of chemistry signifies nothing; for a compulsory change in their brands would leave them where they were formerly, in spite of test bars and the like. The true scientist does not sneer at the founder who does not swallow whole everything said in favor of chemistry in the foundry. He knows that to-morrow might bring forth a discovery far in advance of even chemical methods. He therefore seeks to aid the founder to the best of his ability, and also knows that the intelligent use of test bars is an excellent thing. Chemical tests, combined with physical tests, give the best results in the light of our present knowledge.

"On a strict examination to learn how the cheaper grades of iron found their way into foundries not employing chemists, it will be found that the pig-iron dealer brought about this improvement. For, when the foundries employing metallurgical talent began buying from blast furnaces heretofore considered out of their line of requirements, the furnace managers at once sought to extend their market and thus disseminating whatever information they could obtain to aid them in so doing. The result is that many a foundry which would have had to close up permanently has kept above board, while those that would not learn went under."

THE TRADESMAN.

Speaking of Core Mixtures, E. H. Putnam says:

I have not the least desire for a better "binder" than wheaten flour, except that I use molasses water in the sand. The rule 12 to 1 will not answer. On the contrary, a thorough knowledge of iron founding is the only thing that will always answer. I have known foundrymen (?) to go on for years using cores made as the coremaker pleased, and losing a large per cent of work from "blowing," without ever discovering the cause. No wonder there is a demand for a new core mixture! It does not take long to

learn how to do a thing if you only go about it at once, and try hard to learn. And if a foundryman is having trouble with blowing cores he had better set about learning the coremaker's trade right now. Half the coremakers of the whole country don't know what proportion of flour and sand they use. Three-fourths of the foremen don't know what their coremakers are doing. Most coremakers measure the sand with a shovel, and the flour with their hands; and so, when they tell you the proportions used they really give no information.

There is only one right way to do a thing. All other ways are wrong, and in mixing core sand the only right way is to measure both the sand and the flour in vessels in such a way that you know the exact proportions. Proceeding thus, if there result any blowing of cores, the proportion of flour may be intelligently lessened, provided the trouble lies in this direction. The venting may be, and often is, defective. The vent must be ample, and perfectly protected from the molten iron. This is a matter of course, I know, but yet many a man who objects to being told so obvious a fact never would have thought of it if he hadn't been told.

You must know what provision has been made for vent before you decide whether the proportions of flour and sand are right.

No "core mixture" will take the place of intelligence and painstaking in the core making. But flour is a pretty good binder for core sand if rightly used.

The same author, in "Good Facilities vs. Molding Machines," advances several opinions, the truth of which is but too evident. He says:

All the facilities used in connection with the molding machine must be approximately perfect. There is no escape from this.

The pig-headed perversity of some men in refusing to recognize this fact is the cause of their failure with the machine. Another obstacle to success is that too much is expected of the machine. I have said before now in these columns that a saving of 5 per cent in cost of molding ought to be satisfactory. Especially if along with this there shall be an improvement in quality of

product, and this latter is apt to occur, because, for one reason, the facilities, patterns, follow boards, flasks, etc., must be perfect.

A modern molding machine will cost several hundred dollars. But when you get it together with patterns, stripping plates, flasks, etc., you will have something that, properly used, will give you a good deal of satisfaction, as well as profit. The machine itself will cost, say, $150. One set of patterns to use in the machine will cost, say, $50. Now I have a suggestion to make. Spend $50 on a new pattern and follow board, and make a new set of iron flasks as good and perfect as you will have to provide if you use the machine, and you may pocket the $100 and still get as good and as profitable a product as most of the machines will produce. I do not deny that machines may be used under certain circumstances with profit. But what I wish to emphasize is the fact that you are not doing nearly as well as you might without the machine. Of course I don't mean you personally, but the other fellow! You, personally, almost finish a pattern before you give it to the molder. You, personally, do not require a molder to use a snap flask after it has fallen to pieces! He may be, and in fact is, required to use the flask when the hinges are so worn and loose that the cope will crack wide open every time it is lifted. The screws may be so loose in the snap lock that he is obliged to use the screwdriver several times a day; the corner iron may be broken and the irons on the top edge may be loose at each end and the wood so rotten and worn that it won't hold a screw, still the flask must be used, for, lo! has it not always been used, and that, too, with perfect success?

Yes; and it probably will continue to be used until it shall be superseded by a machine. And the machine not being a man, will get what it asks for, viz: a perfect flask. The man can make an imperfect flask do. He can get along with a poor pattern, and with little or no follow board; therefore, he must. But the machine can't do any of these. Therefore, about half of the purchasers of machines will provide the necessary facilities to make it a success. The other half will spend a good deal of time and money in trying to compel the foreman and his men to do the impossible—that is, to use the machine profitably without proper

facilities and conditions, and then they will set them (the machines) out under a shed and let them rust away.

Many a foundry firm has gone into bankruptcy because it saved dollars on patterns and facilities and spent hundreds of dollars in molders' wages that a reverse policy would have saved.

The application of chemistry to the foundry business has been a fruitful source of discussion during the year now drawing to a close. Every foundrymen's association, the Eastern, Western, Pittsburg and National, have had papers read at their meetings on this subject. Mr. Putnam writes the following on "Chemistry at the Smelting Furnace:"

You can't force everything your way at once, but if you are right, they'll come your way in time. And now, some of the pig iron makers are analyzing their whole product, and the little foundryman can get just the iron he wants without the expense of employing a chemist. Chemistry in the foundry is, generally, chemistry in the wrong place. But at the blast furnace it is properly at home. By the way, I received a letter recently from a prominent writer on foundry topics, charging me with having changed my position on the question of chemistry in the foundry. While such a thing might be, it has not happened yet. I have always conceded the propriety of employing chemistry in some foundries, but have held as unnecessary and impracticable the employment of chemists in foundries generally. I have, however, advocated the practice of analyzing all irons at the blast furnace. Here is the proper place for it; and not long hence it will be difficult for a furnace to sell its product unless a guaranty of its chemical constitution is furnished.

Most foundries to-day have no other means of knowing the quality of their iron than had the foundries of fifty years ago. This is wrong, of course. The physical test is a cheap and effective means of controlling the quality of iron product, and ought to be employed in nearly all foundries—in all, where the quality of the iron cuts any figure. And it is amply sufficient for most foundries, and it will be still more so in the near future. That is. when the smelting furnace describes its iron to the purchaser; the home-made test bar will easily and certainly finish the work.

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